Pediatrics and Neonatology (2012) 53, 138–143

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: http://www.pediatr-neonatol.com

ORIGINAL ARTICLE

Association of ABO Incompatibility With Red Blood Cell Indices of Cord Blood Unit

Shu-Huey Chen [a,b,f], Marie Lin [c], Kuo-Liang Yang [b], Teng-Yi Lin [d], His-Hsiu Tsai [d], Shang-Hsien Yang [a,f], Yu-Hsun Chang [a], Yi-Feng Wu [e], Tso-Fu Wang [b,e,f,*]

[a] *Department of Pediatrics, Buddhist Tzu-Chi General Hospital, Hualien, Taiwan*
[b] *Buddhist Tzu-Chi Stem Cells Center, Buddhist Tzu-Chi General Hospital, Hualien, Taiwan*
[c] *Transfusion Medicine Research Laboratory, Mackay Memorial Hospital, Taipei, Taiwan*
[d] *Department of Laboratory Medicine, Buddhist Tzu-Chi General Hospital, Hualien, Taiwan*
[e] *Department of Hematology and Oncology, Buddhist Tzu-Chi General Hospital, Hualien, Taiwan*
[f] *Department of Medicine, College of Medicine, Tzu-Chi University, Hualien, Taiwan*

Received Jun 13, 2011; received in revised form Aug 19, 2011; accepted Sep 9, 2011

Key Words
abo incompatibility;
cord blood unit;
hematocrit;
hemoglobin;
red blood cell

Background: Maternal–fetal ABO incompatibility is one of the causes of neonatal hyperbilirubinemia. We postulate that hemoglobin (Hb), hematocrit (Hct), and red blood cell (RBC) values for cord blood units (CBUs) are lower and erythroblast values higher for maternal–fetal ABO incompatible dyads than for compatible dyads.
Objective: We investigated the relationship between Hb, Hct, RBC, and erythroblast CBU values and maternal–fetal ABO blood type compatibility.
Methods: Mothers having blood group O who gave birth to infants with blood group A, B, or AB were classified as Group I. According to baby's blood group, the members of Group I were further divided into AO (baby group A, mother group O), BO (baby group B, mother group O), and ABO (baby group AB, mother group O) subgroups. Mothers having blood group A who gave birth to infants with blood group B or AB and mothers having blood group B who gave birth to infants with blood group A or AB were classified as Group II. All other maternal–fetal blood type pairs were considered ABO compatible and were classified as Group III. We compared mean Hb, Hct, RBC, and erythroblast values for the infants' CBUs among these three groups including the subgroups of Group I.
Results: Group I had lower mean Hb, Hct, and RBC values than Group II and Group III (both $p < 0.001$). Although the mean Hb, Hct, and RBC values for Group II were lower than for

* Corresponding author. Department of Hematology and Oncology, Buddhist Tzu-Chi General Hospital, Hualien, 707, Sec. 3, Chung-Yang Road, Hualien 970, Taiwan.
E-mail address: tfwang@tzuchi.com.tw (T.-F. Wang).

doi:10.1016/j.pedneo.2012.01.012

Group III, the difference was not statistically significant. Mean Hb and RBC for the AO group were higher and nucleated RBC (nRBC) ratios were lower than for the BO group; however, these differences were also not statistically significant. Interestingly, the mean Hct value of the BO group was significantly lower than that of the AO group ($p = 0.04$).
Conclusion: Group A or B neonates with a group O mother have lower mean Hb, Hct, and RBC values for CBUs than other neonates. The role of RBC indices in predicting neonatal hemolytic hyperbilirubinemia remains unclear and further studies are needed to identify the possible clinical association.

1. Introduction

Hemolytic disease of the newborns (HDN) due to maternal antibodies is a situation in which the lifespan of the neonate's red cells is shortened due to the activity of transplacental maternal antibodies. More than 99.5% of Taiwanese are D Rh positive and, therefore, HDN due to anti-D antibodies is rarely encountered.[1] In addition, hemolytic disease resulting from ABO incompatibility is clinically milder than anti-D disease. However, HDN and kernicterus do occasionally occur, and hydrops fetalis has been suggested as a result.[2,3] Thus, it is desirable to have a simple and reliable test that is able to predict the development of neonatal hyperbilirubinemia due to ABO incompatibility, after which preventive phototherapy can be used. Hemoglobin (Hb) levels, hematocrit (Hct) counts, reticulocyte counts, direct Coombs test results, bilirubin levels, and immunoglobulin G (IgG) titers that have been obtained from cord blood together with maternal anti-A/anti-B titers have been suggested as approaches for predicting the severity of hyperbilirubinemia in ABO HDN.[4–10]

A complete blood count (CBC) test is an absolute requirement before any CBU cryopreservation. CBC testing of CBUs is noninvasive, convenient, simple, and rapid. We hypothesized that ABO incompatibility influences Hb, Hct, red blood cell (RBC), and erythroblast values obtained from CBU. The veracity of this hypothesis could be tested using reference data and then used to help predict ABO incompatibility that is related to HDN. Most studies reported in the literature, when obtaining CBC samples, have used cord blood obtained directly from the umbilical veins at delivery rather than cord blood units. To our best knowledge, no similar study has been reported to date involving a sample of this great size. Using 3688 CBUs, we studied the impact of differences in the mothers' and fetuses' blood type combinations on Hb, Hct, RBC, and erythroblast values for CBUs.

2. Materials and Methods

2.1. Cord blood collection

Between September 2001 and November 2006, donated cord blood samples from healthy Taiwanese singleton neonates with a gestational age more than 36 weeks born to married mothers were collected by the Tzu Chi Cord Blood Bank. CBUs with a net weight of more than 90 g were accepted. CBUs where one parent carried thalassemia were not accepted, and collected CBUs were discarded if the baby was diagnosed as having glucose-6-phosphate dehydrogenase deficiency (G-6-PD) deficiency. Written informed consent was obtained from the mother donating the CBU before collection. All CBUs were collected *in utero* using a standard procedure. After delivery, the cord was sterilized and a 16-gauze needle was inserted into the umbilical vein. The cord blood was collected by gravity into a collecting bag containing 28 mL anticoagulant phosphate-citrate-dextrose. The bag was stored at 4°C to 10°C and sent to Tzu Chi Cord Blood Bank within 24 hours. Between 1 mL and 2 mL of the aspirated cord blood from cord blood bag was infused into an EDTA tube. Subsequently, the cord blood CBC, white blood cell differential count (WBC DC), Rh typing, and ABO typing were analyzed in the central laboratory of Hualien Buddhist Tzu Chi General Hospital by experienced technicians. Blood group typing was performed routinely using standard blood bank techniques.

2.2. Analysis of cord blood CBC and WBC DC

The CBC testing included RBC, Hb, Hct, WBC, and platelet counts, which were measured using a Sysmex XE2100™ automated hematology analyzer (Sysmex Corporation, Kobe, Japan). Nucleated RBCs (nRBCs) were reported as the number of nucleated RBCs per 100 WBCs. According to the quality control chart and Westgard rules $1_{3S}/2_{2S}/R_{4S}$, the analyzer was calibrated twice daily using a commercial assayed control cell.[11]

2.3. Materials

Among the 5602 CBUs available, 1913 units lacked some data, and these were excluded. Furthermore, there was only one unit where the mother was AB blood group and baby was O group, therefore we excluded this CBU also. In total, 3688 healthy neonates were included in this study, and these were divided into three groups. Mothers having blood group O who had given birth to infants having blood group A, B, or AB were classified as Group I. Group I consisted of 555 CBUs (A, B, and AB; 305, 247, and 3, respectively) where the newborn's mother's blood group was O. Mothers having blood group A who had given birth to infants having blood group B or AB together with mothers having blood group B who gave birth to infants having blood group